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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICATION FOR LETTERS PATENT

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FOR

ELECTRONICS COMPONENTS LABELLING

ELECTRONICS COMPONENTS LABELLING

FIELD OF THE INVENTION

The invention relates to the identification of electronics components, particularly optoelectronics components, optoelectronics components carriers and optoelectronics components packages.

BACKGROUND OF THE INVENTION

Semi-conductor laser diodes, of the type used in optical fibre communications networks as optical signal sources, are generally fabricated from silicon wafers. Typically, a wafer will yield in the region of 6,000 laser diodes. Current optical networks operate with in excess of 160 different wavelengths of optical signal. Each wafer is usually dedicated to producing laser diodes operable at one specific signal wavelength.

For use in optical networks, each of the laser diodes in a wafer is separated from all the others and is generally installed on an optoelectronics component carrier. Each carrier is effectively a printed circuit board-type mounting for the laser diode and other components, such as capacitors or thermistors, which go to make up an optoelectronics product. The board consists essentially of a substrate with conductive tracks applied to its surface, electrically interconnecting the components. The components and the carrier may be packaged.

Each component, and thus each packaged product of which each component becomes a part, has a unique set of data associated with it. The careful management of this data is essential from the perspective of product work in progress management, component tracking and product operation. For instance, an efficient production

process demands a thorough knowledge of work in progress. It may be necessary to be able to trace, for instance, a laser diode back to the wafer from which it was derived or a capacitor or thermistor or any component forming part of the package back along its supply route. Test data needs to be carried forward to product operation. Laser diodes, for example, may be power rated through a test procedure during the product packaging process and the rating is the one at which the laser diode needs ultimately to operate. Moreover, such ratings can vary from laser diode to laser diode.

The ability to link all the associated critical data to each component or component carrier during any production or packaging step is crucial. At present, optoelectronics product packaging lines may achieve such link using so-called waffle packs. These are two dimensionally partitioned flat packs with of the order of 50-80 cells defined by the partitioning. Each cell serves as a storage location for a component or component carrier throughout the production or packaging process. Each storage location is defined in terms of its row and column position in a particular orientation of the pack. The orientation may be defined by a reference mark, such as a chamfered corner. Each pack is assigned a batch number so that each component or component carrier is identifiable within a batch according to its positional data. The batch number is generally applied to the lid of the pack. Data critical to each component or component carrier may be handled using paper batch sheets and a software map with data for each component or component carrier stored in the corresponding software map location.

At any batch stage in production, each waffle pack is usually offered up to whatever equipment is involved in that stage: all of the components or component carriers may be removed and subsequently replaced following the stage processing. Each component is processed in accordance with the data held in the corresponding location in the software map. If, between removal of the component or component carrier for processing and replacement, the lid of the waffle pack bearing the batch number is lost or misplaced, the waffle pack is rotated, or if components or

component carriers are not replaced in the correct position or components become dislodged, each component or component carrier can no longer easily be linked to its critical data and the production process may be hampered by the delay in re-establishing the situation. At worse, a batch of components may have to be discarded if the situation is irretrievable.

For an optical network package, the component carriers upon which laser diodes tend to be mounted may only be of the order of 5mm x 6mm. As the surface area of the carrier is largely occupied by components, little space is available to apply a label bearing an identifier or the data critical to the component or component carrier. Similarly, each component is so small as to offer very little if any spare space for the attachment of a label.

It is known to label products with coded data labels. These typically comprise a substrate, for example adhesive paper, bearing data encoded as a symbol, such as one-dimensional bar code. The data may be read using suitable optical reading apparatus, such as a laser scanner, and decoded with appropriate processing circuitry.

Conventional coded data labels are too big for accommodation on the space available on an optoelectronics component or component carrier.

OBJECT OF THE INVENTION

The object of the invention is to provide a label for attachment to electronics components, components carriers or components packages; a method of labelling electronics components; a vision system for reading a coded data symbol on an electronics component label; an electronics component labelling system; a labelled electronics component and a method of producing a label for electronics components.

SUMMARY OF THE INVENTION

According to a first aspect, the invention provides a label for electronics components comprising a substrate, a coded data symbol carried by the substrate, wherein the format of the symbol is such as to facilitate accommodation of the substrate on components or carriers for the components.

Having a label which can be attached directly to components or component carriers enables each to be labelled individually during a production and packaging process. As a consequence, the component or carrier is always able to be linked to its critical data, which makes for efficient critical data management. Preferably, the component or component carrier is given a unique identifier, such as a serial number, and all critical data for the component or carrier is built up and stored in a database, for instance on a PC or similar electronic storage means, at a location addressable according to the unique identifier. Thus, simply by obtaining the identifier, the critical data may be retrieved at any time. In addition, a component may be assigned to a batch and its batch number can be included in the critical data. Consequently, batch numbers are fully recoverable. Also, it is not critical that components remain in a specific position in, say, a waffle pack, components will not have to be discarded as a result of mismatching data, operator time will not be consumed rectifying loss of data errors and data on any component may be retrieved at any time during the production process.

Preferably, the format of the symbol is such that the space requirements of the substrate are less than is available on a component or component carrier. There are various suitable formats of symbol such as those known under the designations Data Matrix, MaxiCode, Code One, Aztec Code or QR Code, but the Data Matrix format is preferred. Each has a predefined coding algorithm for encoding data as a pattern of lines, bars, dots or squares etc or any combination thercof as a one or two dimensional symbol. In the case of the Data Matrix format, the symbol comprises a square or rectangular matrix of cells and the coding of the data encapsulated in the symbol determines whether the individual cells are left blank or filled in, so as to

form an overall coded pattern. Within each format there may be further sub-formats. For example, there are various ECC specifications within the Data Matrix format and, for instance, the ECC-200 specification defines a specific size of row x column matrix which enables the encoding of up to 12 data characters in a symbol occupying 300μm x 300μm. Thus, the substrate need only be of the order nominally of 460μm x 460μm. However, the symbol, and hence the substrate, could be smaller.

The substrate may be any material suitable for attachment to a component or component carrier and the symbol may be applied by any suitable method. Preferably, for compatibility with microelectronics components, the substrate is a semiconductor wafer material to which an etchable layer is applied and the symbol is etched into the etchable layer. For example, the wafer material may be silicon nitride and the etchable layer may be gold. The gold may be etched so as to leave gold in those parts corresponding to filled in cells, offering a bright, reflective surface, and no gold in those parts corresponding to blank squares, offering a dark surface. When it comes to reading the symbol, it is the contrast between the bright and dark cells which is important. Further preferably, the etching may be performed using an electron beam or using any other etching technique which can etch accurately at the dimensions required for accommodation of the label on a component. Standard mask techniques are not altogether suitable in situations where each symbol required is unique as this would necessitate a different mask for each symbol, which is uneconomical. Electron beam etching, however, provides the flexibility to easily vary the symbol from label to label.

The symbol has to be read and decoded. The reading is achieved by a vision system comprising light source means for illuminating the symbol, reflection detection means for detecting the reflected light pattern corresponding to the symbol and processing means for decoding the reflected light pattern. Reflection capturing apparatus and light pattern decoding apparatus are well known. Preferably, the light source produces diffuse red light.

The substrate could be the component or components carrier substrate such as the component semiconductor wafer so that the label could be applied directly to the component or carrier rather than as a separate label.

According to a second aspect, the invention provides a method of labelling electronics components comprising attaching to components or carriers for components a substrate carrying a coded data symbol.

According to a third aspect, the invention provides a vision system for reading a coded data symbol on an electronics component label comprising means for producing light for illuminating the symbol and means for detecting the pattern of light reflected from the symbol. Preferably, the light producing means produces diffuse red light.

According to a fourth aspect, the invention provides an electronics component labelling system comprising a label carrying a coded identifier symbol for attachment to a component or component carrier, a vision system for reading and decoding the label and data storage means for storing at a location identifiable according to the decoded identifier data relevant to the component.

According to a fifth aspect, the invention provides an electronics component or component carrier having a label attached thereto, which label comprises a substrate, a coded data symbol carried by the substrate, wherein the format of the symbol is such as to facilitate accommodation of the substrate on the components or carrier.

According to a sixth aspect, the invention provides a method of producing a label for electronics components comprising providing a substrate, providing an etchable layer on the substrate and etching the etchable layer. Preferably, the etching is performed using an electron beam technique.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic plan view of the layout of a optoelectronics component carrier to which is applied a label according to the invention;

Figure 2 is a schematic plan view of a label according to the invention;

Figure 3 is a side cross sectional view of a label according to the invention;

Figure 4 is a schematic side view of vision system for reading and decoding a label according to the invention; and

Figure 5 is a schematic side view of electron beam etching apparatus.

DESCRIPTION OF THE INVENTION

With reference to figure 1, an optoelectronics component carrier indicated generally at 2 has a substrate 4 on the surface of which is a arrangement of conducting strips 6. The conducting strips 6 provide the electrical interconnections between components 8 mounted on the carrier. One of the components 8a is a laser diode. In the figure the carrier is significantly magnified and would in reality be in the order of 5mm x 6mm.

Situated adjacent one of the components 8b, but in a region of the carrier 2 in which there are no components 8 mounted on the substrate 4, and hence there is free space, is a component carrier label 10. With reference also to figure 2, the label 10 comprises a substrate 12 nominally measuring 460μm x 460μm. On the surface of the substrate 12 is a symbol 14. The symbol 14 is in Data Matrix ECC-200 format consisting of 12 row x 12 column matrix of cells. Each matrix cell, that is, each row/column intersection is in either one of two states, blank or filled in. The combination of all the cell states constitutes an encoded identifier, a serial number, for the carrier 2 and all the components 8 mounted on it.

Critical data for the component carrier 2, such as the batch number for the laser diode 8a and its operational values determined during testing, are stored within a database

in a PC 28 (see figure 4) at a location addressable in accordance with the serial number.

With reference also to figure 3, the substrate 12 is a silicon nitride wafer . Applied to the wafer are successive 1000 Å thick layers of chromium 30 and gold 32. Using an electron beam etching apparatus 34 (see figure 5), gold within the boundaries of the symbol is etched according to a desired pattern. In other words, gold 32 is removed from the locations corresponding to matrix cells which are to be left blank and untouched in the locations corresponding to matrix cells which are to be filled in. Thus, the matrix is in the form of a pattern of gold and non-gold cells. The gold cells are bright and reflective whereas the non-gold cells are dark.

With reference to figure 4, the symbol 14 is read and decoded using a vision system indicated generally at 20 having diffused red light source 22 for projecting diffuse red light on to and illuminating the symbol 14 and a reflected light detection apparatus 24 for detecting the pattern of light reflected from the symbol 14 and processing circuitry 26 for decoding the reflected pattern. The diffused red light from the source 22 is scanned across the symbol 14 and the resulting reflected pattern of light corresponding, because of the reflective and non-reflective nature of the filled in and blank matrix cells respectively, is captured as an image by the detection apparatus 24. The captured image is analysed by the processing circuitry 26 and, by applying the Data Matrix ECC-200 coding algorithm in reverse, is decoded. This decoding generates the serial number which can then be used to address a location in the database in the PC 28 where the data critical to the component or component carrier is stored.